JEE(ADVANCED)-2013 PAPER 1

PHYSICS

[Time allowed: 3 hours] **[Maximum Marks: 180]**

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose

INSTRUCTIONS

A. General

1. This booklet is your Question paper. Do not break the seats of his booklet before being instructed to do so by the invigilators.
2. Blank papers, clipboards, log tables, slide rules, calculators, cameras, cellular phones, pagers, and electronic gadgets are NOT allowed inside the examination hall.
3. Write your name and roll number in the space provided on the back cover of this booklet.
4. Answers to the questions and personal details are to be filled on a two-part carbon-less paper, which is provided separately. You should not separate these parts. The invigilator will separate them at the end of examination. The upper sheet is machine-gradable Objective Response Sheet (ORS) which will be taken back by the invigilator. You will be allowed to take away the bottom sheet at the end of the examination
5. **Using a black ball point pen, darken the bubbles on the upper original sheet.** Apply sufficient pressure so that the impression is created on the bottom sheet.

B. Question Paper Format

This question paper consists three sections.
Section 1 contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE are correct**.
Section 2 contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE are correct**.
Section 3 contains **5 questions.** The answer to each question is a single- digit integer, ranging from 0 to 9 (both inclusive).

C. Marking Scheme

For each question **Section 1,** you will be awarded **2 marks** if you darken the bubble corresponding to only the correct answer(s) and zero mark if no bubble are darkened. In all other cases, **minus one (-1)** mark will be awarded
For each question **Section 2,** you will be awarded **4 marks** if you darken the bubble corresponding to only the correct answer(s) and **zero mark** if no bubble are darkened. In all other cases, minus one (-1) mark will be awarded
For each question **Section 3,** you will be awarded **4 marks** if you darken the bubble corresponding to only the correct answer(s) and **zero mark** if no bubble are darkened. In all other cases, minus one (-1) mark will be awarded

PART - 1: PHYSICS

SECTION - 1: (Only one option correct Type)

This section contains **10 multiple choice questions.** Each question has four choice (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

*** 1.** One end of a horizontal thick copper wire of length $2L$ and radius $2R$ is welded to an end of another horizontal thin copper wire of length L and radius R. When the arrangement is stretched by applying forces

at two ends, the ratio of the elongation in the thin wire to that in the thick wire is

(A) 0.25

(B) 0.50

(C) 2.00

(D) 4.00

2. The work done on a particle of mass m by a force $K\left[\frac{x}{\left(x^2+y^2\right)^{3/2}}\hat{i}+\frac{y}{\left(x^2+y^2\right)^{3/2}}j\right]$ (K being a constant of appropriate dimensions, when the particle is taken from the point $(a,0)$ to the point $(0,a)$ along a circular path of radius a about the origin in the $x-y$ plane is

(A) $\frac{2k\pi}{a}$

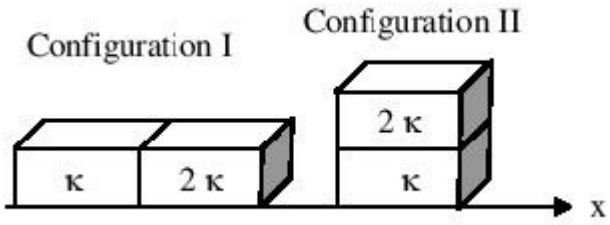
(B) $\frac{k\pi}{a}$

(C) $\frac{k\pi}{2a}$

(D) 0

3. Two rectangular blocks, having identical dimensions, can be arranged either in configuration I or in configuration II as shown in the figure. One of the blocks has thermal conductivity k and the other $2k$. The temperature difference between the ends along the

x-axis is the same in both the configurations. It takes $9\,s$ to transport a certain amount of heat from the hot end to the cold end in the configuration I The time to transport the same amount of heat in the configuration II is



(A) $2.0\,s$

(B) $3.0\,s$

(C) $4.5\,s$

(D) $6.0\,s$

4. A ray of light travelling in the direction $\frac{1}{2}\left(\hat{i}+\sqrt{3}\hat{j}\right)$ is incident on a plane mirror. After reflection, it travels along the direction $\frac{1}{2}\left(\hat{i}-\sqrt{3}\hat{j}\right)$ The angle of incidence is

(A) $30°$

(C) $60°$

(B) $45°$

(D) $75°$

*** 5.** The diameter of a cylinder is measured using a Vernier callipers with no zero error. It is found that the zero of the Vernier scale lies between $5.10\,cm$ and $5.15\,cm$ of the main scale. The Vernier scale has 50 divisions equivalent to $2.45\,cm$. The 24^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. The diameter of the cylinder is

(A) $5.112\,cm$

(B) $5.124\,cm$

(C) $5.136\,\text{cm}$

(D) $5.148\,\text{cm}$

*** 6.** Two non-reactive monoatomic ideal gases have their atomic masses in the ratio $2:3$. The ratio of their partial pressures, when enclosed in a vessel kept at a constant temperature, is $4:3$. The ratio of their densities is

(A) $1:4$

(B) $1:2$

(C) $6:9$

(D) $8:9$

7. In the Young's double slit experiment using a monochromatic light of wavelength λ, the path difference (in terms of an integer n) corresponding to any point having half the peak intensity is

(A) $(2n+1)\frac{\lambda}{2}$

(B) $(2n+1)\frac{\lambda}{4}$

(C) $(2n+1)\frac{\lambda}{8}$

(D) $(2n+1)\frac{\lambda}{16}$

8. The image of an object, formed by a plano-convex lens at a distance o f 8m behind the lens, is real and is one-third the size of the object. The wavelength of light inside the lens is $\frac{2}{3}$ times the wavelength in free space. The radius of the curved surface of the lens is

(A) 1m

(B) $2\,\text{m}$

(C) 3m

(D) $4\,\text{m}$

9. A particle of mass m is projected from the ground with an initial speed u_0 at an angle a with the horizontal. At the highest point of its trajectory, it makes a completely inelastic collision with another identical particle, which was thrown vertically upward from the ground with the same initial speed u_0. The angle that the composite system makes with the horizontal immediately after the collision is

10. A pulse of light of duration $100\,\text{ns}$ is absorbed completely by a small object initially at rest. Power of the pulse is $30\,\text{mW}$ and the speed of light is $3\times10^8\,m/s$. The final momentum of the object is

(A) $0.3\times10^{-17}\,kg\,ms^{-1}$

(B) $1.0\times10^{-17}\,kg\,ms^{-1}$

(C) $3.0\times10^{-17}\,kg\,ms^{-1}$

(D) $9.0\times10^{-17}\,kg\,ms^{-1}$

SECTION - 2 : (One or more options correct Type)

This section contains **10 multiple choice questions.** Each question has four choice (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

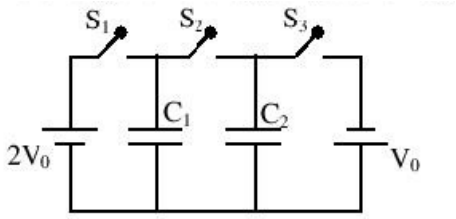
11. In the circuit shown in the figure, there are two parallel plate capacitors each of capacitance C . The switch S| is pressed first to fully charge the capacitor C_1 and then released. The switch S_1 is then pressed to charge the capacitor C_2. After some time, S_2 is released and then S_3 is pressed. After some time,

(A) the charge on the upper plate of C_1 is $2CV_0$.

(B) the charge on the upper plate of C_1 is CV_0.

(C) the charge on the upper plate of C_1 is 0.

(D) The charge on the upper plate of C_2 is $-CV_0$.



12. A particle of mass M and positive charge Q, moving with a constant velocity $u_1 = 4\hat{i}ms^{-1}$, enters a region of uniform static magnetic field normal to the $x-y$ plane. The region of the magnetic field extends from $x=0$ to $x=L$ for all values of y. After passing through this region, the particle emerges on the other side after 10 milliseconds with a velocity $\vec{u}_2 = 2\left(\sqrt{3}\hat{i}+\hat{j}\right)m/s^{-1}$. The correct statement (s) is (are)

(A) The direction of the magnetic field is $-z$ direction.

(B) The direction of the magnetic field is $+z$ direction.

(C) The magnitude of the magnetic field $\frac{50\pi M}{3Q}$ units.

(D) The magnitude of the magnetic field is $\frac{100\pi M}{3Q}$ units.

13. A horizontal stretched string fixed at two ends, is vibrating in its fifth harmonic according to the equation $y(x,t) = 0.01\text{m}\sin\left[\left(62.8m^{-1}\right)x\right]\cos\left[\left(628s^{-1}\right)t\right]$. Assuming it $\pi = 3.14$, the correct statement (s) is (are)

(A) The number of nodes is 5.

(B) the length of the string is 0.25m.

(C) The maximum displacement of the midpoint of the string, from its equilibrium position is 0.01m.

(D) The fundamental frequency is $100\,\text{Hz}$.

14. A solid sphere of radius R and density ρ is attached to one end of a mass-less spring o f force constant k. The other end of the spring is connected to another solid sphere of radius R and density 3ρ. The complete arrangement is placed in a liquid of density 2ρ and is allowed to reach equilibrium. The correct statement(s) is (are)

(A) the net elongation of the spring is $\frac{4\pi R^3 \rho g}{3k}$

(B) the net elongation of the spring is $\frac{8\pi R^3 \rho g}{3k}$

(C) the light sphere is partially submerged.

(D) the light sphere is completely submerged.

15. Two non-conducting solid spheres of radii R and $2R$, having uniform volume charge densities ρ_1 and ρ_2 respectively, touch each other. The net electric field at a distance $2R$ from the centre of the smaller sphere, along the line joining the centre of the spheres is zero. The ratio ρ_1/ρ_2 can be

(A) -4

(B) $-\frac{32}{25}$

(C) $\frac{32}{25}$

(D) 4

SECTION - 3 : (Integer value correct Type)

This section contains **5 questions.** The answer to each question is **a single digit integer,** ranging from 0 to 9 **(***both inclusive***)**

*** 16.** A bob o f mass m, suspended by a string of length l_1 is given a minimum velocity required to complete a full circle in the vertical plane. At the highest point, it collides

elastically with another bob of mass m suspended by a string of length l_2, which is initially at rest. Both the strings are mass-less and inextensible. If the second bob, after collision acquires the minimum speed required to complete a full circle in the vertical plane, the ratio l_1/l_2 is

***17.** A particle of mass $0.2\,\text{kg}$ is moving in one dimension under a force that delivers a constant power $0.5\,\text{W}$ to the particle. If the initial speed $(in\ m/s)$ of the particle is zero, the speed $(in\ m/s)$ after $5\,\text{s}$ is

18. The work functions of Silver and Sodium are 4.6 and $2.3eV$, respectively. The ratio of the slope of the stopping potential versus frequency plot for Silver to that of Sodium is

19. A freshly prepared sample of a radioisotope of half-life $1386\,s$ has activity 10^3 disintegrations per second. Given that $\text{in } 2 = 0.693$, the fraction of the initial number of nuclei (expressed in nearest integer percentage) that will decay in the first $80\,s$ after preparation of the sample is

20. A uniform circular disc of mass $50\ kg$ and radius $0.4\ \text{m}$ is rotating with an angular velocity of $10\,rad\,s^{-1}$ about its own axis, which is vertical. Two uniform circular rings, each of mass $6.25\ kg$ and radius $0.2\ \text{m}$, are gently placed symmetrically on the disc in such a manner that they are touching each other along the axis of the disc and are horizontal. Assume that the friction is large enough such that the rings are at rest relative to the disc and the system rotates about the original axis. The new angular velocity (in $rad\,s^{-1}$) of the system is